

Scientific Inquiry

- 6-1 The student will demonstrate an understanding of technological design and scientific inquiry, including the process skills, mathematical thinking, controlled investigative design and analysis, and problem solving.**

6-1.2 Differentiate between observation and inference during the analysis and interpretation of data.

Taxonomy Level: 4.1-B Analyze Conceptual Knowledge

Previous/Future knowledge: In kindergarten (K-1.3), students predicted and explained information or events based on observation or previous experience. In 3rd grade (3-1.4), students predicted the outcome of a simple investigation and compare the result with the prediction. In 4th grade, students classified observations as either quantitative or qualitative (4-1.1) and distinguished among observations, predictions, and inferences (4-1.4). In 5th grade (5-1.6), students evaluated results of an investigation to formulate a valid conclusion based on evidence and communicated the findings of the evaluation in oral or written form. In 8th grade (8-1.3), students will construct explanations and conclusions from interpretations of data obtained during a controlled scientific investigation.

It is essential for students to know that data should be collected throughout a controlled scientific investigation. Data includes both scientific observations and inferences.

- A *scientific observation* is gained by carefully identifying and describing properties using the five senses or scientific tools and can be classified as *quantitative* or *qualitative*.
 - Quantitative observations are observations that use numbers (amounts) or measurements (including the unit label) or observations that make relative comparisons, such as more than, all, less than, few, or none.
 - Qualitative observations are observations that are made using only the senses and refer to specific properties.
- An *inference* is an explanation or interpretation of an observation based on prior experiences or supported by observations made in the investigation. They are not final explanations of the observation. There may be several logical inferences for a given observation. There is no way to be sure which inference best explains the observation without further investigation.

Data from the investigation should be organized in data tables and represented as diagrams or graphs when appropriate.

A *data table* is used to organize data collected in an experiment so that it can be read easily.

- A data table should be planned before the investigation starts.
- Consider the purpose of the table, the kind and number of items to be included in the table, the number of times a measurement will be made, and the units to be used.
- Data tables are often organized in columns and rows. The columns should have headings that show the quantity and unit of the data in that column.
- The independent (manipulated) variable is listed in the column on the left side. The dependent (responding) variable is listed in the column(s) on the right side.
- If qualitative data is to be gathered, include enough space to write the observations.

Diagrams can be used to identify specific parts or how they work, sequence of events, or how things are alike and different.

Graphs are visuals used to compare data. Graphs show not only information but also relationships between the data. Different types of graphs show different types of information.

- Pictographs use pictures of objects to show quantities.

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- Bar graphs are often used for qualitative observations. The lengths of the bars on a bar graph are used to represent and compare data. A numerical scale is used to determine the lengths of the bars.
- Circle graphs show percentages of a whole. The entire circle is equal to 100% of the data.
- Line graphs are often used when quantitative data is collected over time. Line graphs show how quantitative data changes over time or relationships between manipulated (changing) variable and responding (resulting) variable. The lines on a line graph show the pattern of changes at a glance.

Line graphs are used to represent data that has been collected over a determined amount of time. To construct a line graph, the following steps should be taken:

- Draw a horizontal line (x-axis) and a vertical line (y-axis) that meet at a right angle.
- Identify the independent (manipulated) variable and the dependent (responding) variable from the data.
 - The independent (manipulated) variable is written on the x-axis.
 - The dependent (responding) variable is written on the y-axis.
 - Include appropriate units of measurement for each variable.
- Look at the range of data (lowest and highest) to determine the *intervals* or *increments* (numbers on the axes) of the x-axis and the y-axis.
 - The increments do not need to be the same for both the x-axis and the y-axis, but should be consistent on either axis.
 - Label the point at the right angle as zero (0).
- Plot the data on the graph as matched pairs. For example, every independent (manipulated) variable number will have a corresponding dependent (responding) variable number.
- Connect the points on the line graph.
- Write an appropriate title for the graph that contains the names of both variables.

NOTE TO TEACHER: A mnemonic device that can be used to teach the appropriate locations of the variables on a graph is DRY MIX.

- DRY represents Dependent-Responding-Y-axis.
- MIX represents Manipulated-Independent-X-axis.

In order to be meaningful, the data collected from the investigation should be interpreted and analyzed.

- How the data is analyzed depends on the experiment.
- Sometimes calculations or graphs will be needed to help analyze the data.
- Data will often reveal patterns or trends.
- Patterns often become clear if the data is organized in a data table or graph.

The analyzed data can then be used to draw a valid conclusion about the investigation.

- A *valid conclusion* is a summary of the findings of an experiment based on scientific observations, inferences, and collected data that states the relationship between the independent (manipulated) and dependent (responding) variables.
- When a conclusion statement is made it should state whether the collected data supports the hypothesis or does not support the hypothesis (not that the hypothesis was right or wrong).

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It is not essential for students to generate new questions from an investigation or construct circle graphs.

Assessment Guidelines:

The objective of this indicator is to *differentiate* between observations and inferences during the analysis and interpretation of data; therefore, the primary focus of assessment should be to distinguish between observations and inferences that can be made from the data collected during an investigation. However, appropriate assessments should also require students to *identify* the appropriate type of graph for the data collected; *compare* observations and inferences; *interpret* data presented on a graph or diagram; *implement* the steps for making a data table or graph;